LAWRENCEVILLE GEOLOGICAL SCIENCE FIELD TRIP

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Field Trip 1985D
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Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION
Champaign, Illinois 61820

Miles to next point	Miles from starting point	
0.0	0.0	Assemble at the southeast corner of Lawrenceville High School at the intersection of Charles and 8th Streets (mileage figures start at this intersection). HEAD SOUTH on 8th Street.
0.1+	0.1+	STOP (1-way): T-intersection with State Street. TURN RIGHT (west) and prepare to turn left at next corner.
0.05-	0.15	TURN LEFT (south) on 9th Street.
0.05	0.2	STOP (2-way): Jefferson Street. CONTINUE AHEAD (south).
0.1+	0.3+	STOP (2-way). TURN RIGHT (west) on Lexington Avenue.
0.2-	0.5-	STOP (4-way): 12th Street. CONTINUE AHEAD (west).
0.15-	0.65-	CAUTION: Rough abandoned railroad crossing.
0.05+	0.7-	CAUTION, STOPLIGHT: 15th Street/State Route (SR)-1. CONTINUE AHEAD (west).
0.05+	0.75+	BEAR LEFT (southwest) on Porter Avenue at "R"-intersection.
0.15-	0.9+	STOP (4-way). CONTINUE AHEAD (southwest).
0.4	1.3	CAUTION: crossroad (1030N, 1140E), end of macadam. CONTINUE AHEAD (southwest) on the gravel.
0.45+	1.75+	BEAR RIGHT (west).
0.35-	2.1-	T-road from left (1000N, 1070E). CONTINUE AHEAD and stop just beyond the intersection.
0.05-	2.1	**STOP 1. View toward the southeast of the abandoned Texaco Oil Company refinery and its tank farm to the right.**
0.0	2.1	Leave Stop 1 and CONTINUE AHEAD (west).
0.25-	2.35-	TURN RIGHT (north) at T-road intersection (1000N, 1050E).
0.5	2.85-	STOP (1-way): T-road intersection (1050N, 1050E), SR-250. TURN RIGHT (east) and prepare to turn left at the second opportunity, which is 1070E.

Miles to next point	Miles from starting point	
0.1	2.95-	CAUTION: TURN LEFT (north) on the east side of the subdivision (1050N, 1070E).
0.15+	3.1	The wooden tank ahead is a relic from the early days of oil development in this area. The wooden shed to the right covers several large wooden tanks. To the right of the wooden shed is a more modern oil collection system of steel and fiberglass tanks. TURN LEFT (west) (1070N, 1070E).
0.05	3.15	TURN LEFT (south) (1070N, 1060E).
0.15+	3.3+	STOP (1-way): T-intersection with SR-250. TURN RIGHT (westerly).
0.4	3.7+	To the left is an operating pumpjack. CONTINUE AHEAD (west).
1.45	5.15+	CAUTION: enter town of Bridgeport.
0.65	5.8+	To the right is the Northeast District Production Office of Marathon Oil Company. CONTINUE AHEAD (west).
0.1+	5.95-	STOP (4-way): crossroad (1000N, 800E). TURN RIGHT (north).
0.95-	6.85+	STOP (2-way): crossroad, U.S. 50 (1090N, 800E). CAUTION: CONTINUE AHEAD (north).
0.1-	6.95	CAUTION: T-road intersection (1100N, 800E). JOG LEFT (west) along township road and THEN RIGHT (north).
0.15+	7.1+	The two pumpjacks to the left that are close together are pumping from different pay zones. There are a number of paired pumpjacks in this area.
0.15+	7.25+	Most of the large-scale oil production from the Lawrence oil and gas field is from the northwesterly-trending La Salle Anticlinal structure. This structure flattens out about 1/4 mile to the east. As our itinerary is north of the crest of the structure and is crossing it diagonally, we are going down dip on the structure as we proceed northward.
0.7+	8.0	Note view to the right. TURN LEFT (west) at T-road intersection (1200N, 800E).

Miles to next point	Miles from starting point	
0.65	8.65	To the right are a couple of water injection wells.
0.3	8.95	**STOP 2. Lewis water treating plant, Section 29-4N-12W, Marathon Oil Company.**
0.0	8.95	Leave Stop 2 and CONTINUE AHEAD (west).
0.05	9.0	CAUTION: crossroads (1200N, 700E). The hamlet of Petrolia is about one mile to the north.
0.95+	9.95+	STOP (2-way): crossroad (1200N, 600E). TURN RIGHT (north).
1.0+	11.0-	STOP (1-way): T-road intersection (1300N, 600E).
1.55	12.55	**STOP 3. Discussion of waterflood operation and the spacing of wells at the LACT Unit.**
0.0	12.55	Leave Stop 3. CONTINUE AHEAD (north).
0.45	13.0	TURN LEFT (west) at crossroad (1500N, 600E). CAUTION: loose gravel.
0.75	13.75	Concrete bridge over the slough. CONTINUE AHEAD (west).
0.15+	13.9+	CAUTION: T-road intersection (1500N, 500E). NO STOP. TURN RIGHT (north) and prepare to turn left.
0.1-	14.0-	TURN LEFT (west).
1.0+	15.0	CAUTION: crossroad (1500N, 400E). TURN LEFT (south) onto 400E.
0.55+	15.55+	CAUTION: loose gravel. CONTINUE AHEAD (south).
0.55-	16.1-	CAUTION: narrow bridge.
0.2+	16.3+	Concrete bridge over Muddy Creek.
0.8	17.1+	CAUTION: You are now on an old single -lane, concrete slab. Some of the first concrete road put down in the area. <u>It is rough!</u>
0.95	18.05-	STOP (1-way): T-road intersection (1200N, 400E). TURN LEFT (west).

Miles to next point	Miles from starting point	
0.05-	18.05+	TURN LEFT (south) on a narrow road. This is the north entrance to Red Hills State Park.
0.25-	18.3	CAUTION: bad bump just below the crest of the hill.
0.05	18.35+	**STOP 4. Discussion of the Vincennes Tract and early land surveys of Illinois.**
0.0	18.35+	Leave Stop 4 and CONTINUE AHEAD (southwesterly).
0.65	19.0+	CAUTION: T-road intersection. TURN RIGHT (westerly). Visibility is restricted to the left.
0.2+	19.2+	BEAR RIGHT (northerly) on park drive at "R" intersection.
0.1-	19.3	**STOP 5. Lunch at the pavilion.**
0.0	19.3	Leave Stop 5. CONTINUE AHEAD on the drive.
0.15+	19.45+	CAUTION: intersection with main park road. BEAR LEFT (southeasterly) on the main park road and continue ahead to U.S. 50.
1.05+	20.55-	STOP (2-way). U.S. 50. TURN LEFT (east). CAUTION: fast cross traffic.
2.30	22.85-	Prepare to stop on shoulder.
0.1-	22.9+	CAUTION: Pull off the highway to the right and stop.
		STOP 6. Discussion of early oil recovery equipment.
0.0	22.9+	Leave Stop 6. USE EXTREME CAUTION in pulling back onto the highway. CONTINUE AHEAD (east).
1.1-	24.0-	CAUTION: Bridgeport Road. CONTINUE AHEAD (east).
2.8+	26.8	CAUTION: approaching Lawrenceville interchange.
0.15+	26.95+	BEAR LEFT (northeast) at the Lawrenceville interchange toward the Lawrenceville-Marshall interchange.

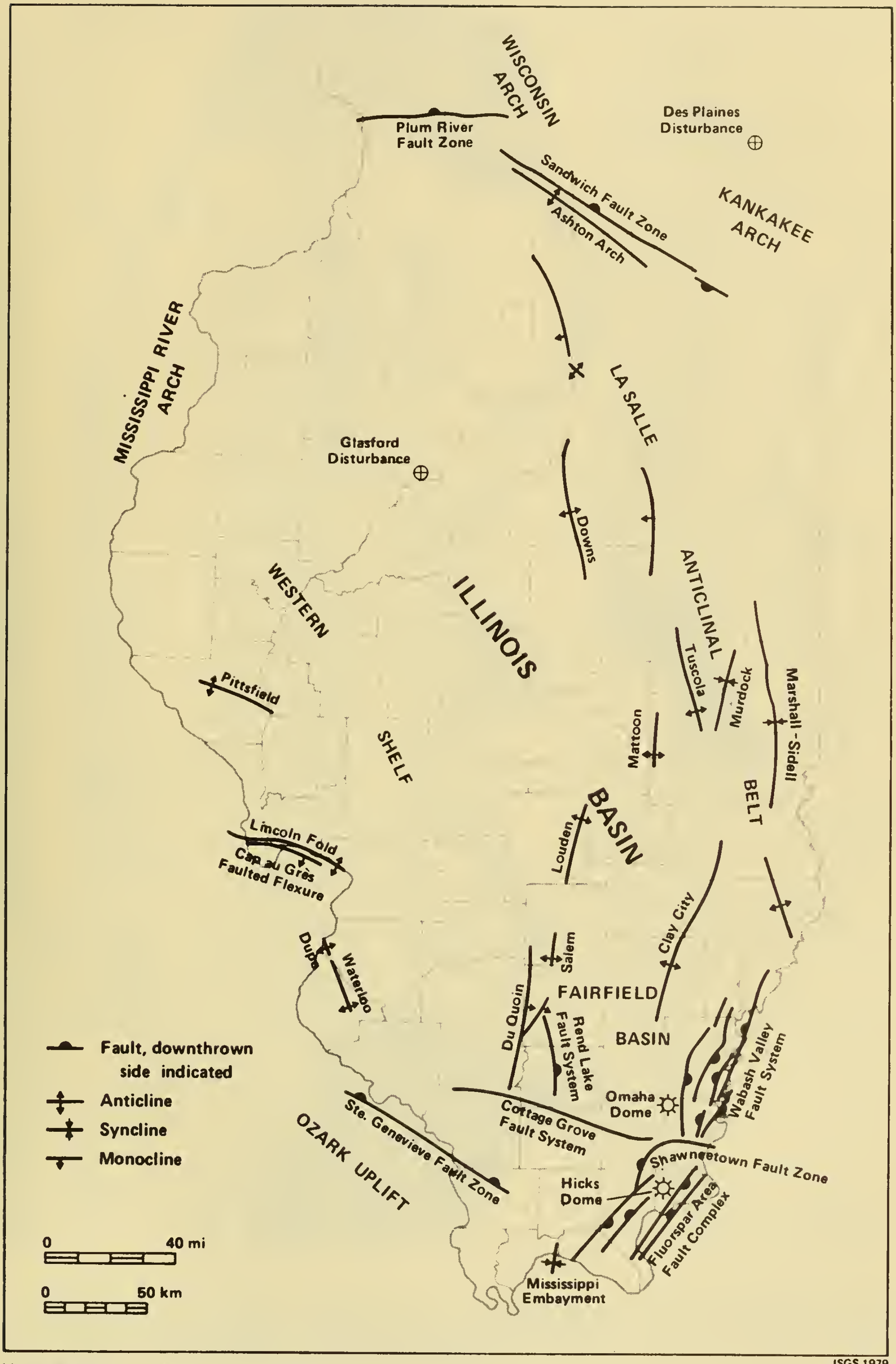
MIles to next point	**Miles from starting point**	
0.45	27.4	Prepare to stop on shoulder.
0.15-	27.55-	**STOP 7. Pennsylvanian bedrock exposure and landslide in highway cut.**
0.0	27.55-	Leave Stop 7. CONTINUE AHEAD (east). Re-enter highway with caution.
0.15+	27.7	Cross Embarras River.
0.25	27.95	Turn right (southeasterly) at the Lawrenceville-Marshall exit.
0.2+	28.15+	STOP (1-way): intersection with SR-1. TURN RIGHT (south) on the divided 4-lane highway.
0.15-	28.3	CAUTION: highway narrows to two lanes, not divided. Prepare to turn left.
0.1-	28.4-	CAUTION: TURN LEFT (easterly) just before the Embarras River bridge.
0.05+	28.45+	CAUTION: rough abandoned rail crossing. CONTINUE AHEAD (easterly).
0.15+	28.6+	CAUTION: Y-intersection (1110N, 1220E). BEAR RIGHT.
0.05	28.65+	CAUTION: TURN LEFT and prepare to park. Do not block the approaches to the bridge. Be careful of poison ivy.
		STOP 8. Pennsylvanian bedrock exposure in south bank of Embarras River west of the old 10th Street iron bridge; Holocene slump block of silts west of the north bridge abutment.
0.0	28.65+	Leave Stop 8. CONTINUE AHEAD to the left (northeast).
0.05-	28.7+	STOP (1-way): Y-intersection. BEAR RIGHT (northeast).
0.15+	28.85+	CAUTION: Leave the rough blacktop and enter gravel.
0.15+	29.05-	U.S. 50 overpass. CONTINUE AHEAD (northeast) and prepare to turn right.

Miles to next point	Miles from starting point	
0.05+	29.1	TURN RIGHT (southeast) at T-road intersection (1130N, 1260E).
0.9+	30.0+	CAUTION: narrow wood plank bridge over Otter Pond Ditch. Notice the refuse dumping in this area.
0.3-	30.3	Ascending from the alluviated bottomlands up onto the relatively flat valley train deposits. The slightly rolling character of the surface is due to channel shifting and some small sand dunes. A stand of pines a half mile to the north was put there to help stabilize a small sand dune. To the right (south) is a bedrock high that is covered by sand. It is called Sand Ridge.
0.8	31.1	This elevated area probably is another small bedrock high that has a thin sandy, valley train covering.
0.45	31.55	STOP (1-way): Y-intersection (1100N, 1500E). CONTINUE AHEAD (east).
0.6-	32.15-	CAUTION: Y-intersection. Airport Road to the left. CONTINUE AHEAD (east).
0.6+	32.75	To the right, about a half mile, is a city water well house.
0.3+	33.05+	CAUTION: crossroad (1100N, 1650E). It is offset slightly because we are travelling across a township road. TURN LEFT (north).
0.35-	33.4	Notice how flat the valley train deposits are here.
0.6	34.0	Ahead is the Lawrenceville-Vincennes Municipal Airport.
0.1+	34.1+	CAUTION: T-road intersection (1200N, 1650E). TURN RIGHT (east) onto gravel.
0.5	34.6+	STOP (1-way): crossroad (1200N, 1700E). CONTINUE AHEAD (east) on the blacktop and then curve left (north) in 1/2 mile.
0.2	34.8	To the right (southeast), slightly over 3.5 miles, the tree line is on Robeson Hills, a bedrock hill. Meltwater torrents from the melting Wisconsinan glaciers cut down through

Miles to next point	Miles from starting point	
		a low place (sag) in the surface of Indiana and left this isolated remnant now on the Illinois side of the river. Bedrock of Pennsylvanian age is exposed along the east side of the hill.
0.5-	35.3-	T-road from right. CONTINUE AHEAD (north). The flat, valley train surface here has made an ideal site for an airport since little grading was necessary for constructing the large runways.
0.6+	35.9	We are coming down off of the valley train terrace into one of the old distributary channels now occupied by a drainage ditch (Allison Ditch).
0.15	36.05	To the left, just south of the cemetery, a considerable amount of refuse has been dumped in a small abandoned gravel pit.
0.55+	36.6+	CAUTION: crossroad (1350N, 1740E). TURN LEFT (west) on very rough road.
0.05+	36.7-	Entrance gate to an abandoned sand and gravel pit.
0.05+	36.75-	Park in the wide area from which several lanes lead to different parts of the pit. Don't block the entrance lane.
		STOP 9. Discussion of refuse dumps in abandoned sand and gravel pits and the effect on groundwater quality.
0.0	36.75-	Leave Stop 9 and retrace route to the blacktop.
0.1-	36.8+	STOP: crossroad (1350N, 1740E). TURN LEFT (north) on the blacktop.
0.65-	37.45	Ascend the Maumee Terrace.
0.85+	38.3+	CAUTION: crossroad (1400N, 1650E). TURN RIGHT (north) on the blacktop.
0.5	38.8+	STOP (1-way): T-road intersection (1450N, 1650E). TURN LEFT (west).

Miles to next point	Miles from starting point	
0.5	39.3+	CAUTION: T-road intersection (1450N, 1600E). TURN RIGHT (northerly) and cross Beaver Pond Ditch located in another old distributary channel.
0.2-	39.5-	CAUTION: Otter Pond Ditch bridge.
0.15+	39.65+	Sharp left turn and then a right turn around a gravel pit.
0.25-	39.9-	Allendale Gravel Pit entrance. CONTINUE AHEAD (north).
0.15+	40.05	CAUTION: R-road intersection (1500N, 1570E). BEAR LEFT (west).
0.35	40.4	Ascend Maumee Terrace again.
0.3+	40.7+	Ascend slopes of upland.
0.95-	41.65	Prepare to turn left.
0.15-	41.8-	TURN LEFT (south) at T-road intersection (1500N, 1400E).
0.9+	42.7	Descend from Maumee Terrace into old distributary channel.
0.4-	43.1-	Cross Otter Pond Ditch bridge.
0.1+	43.2	Several gravel pits are located on both sides of the road ahead. Only the pit on the left side is operating. Those on the right side are smaller and have been converted to campsites.
0.7-	43.9-	TURN LEFT (east) at T-road intersection (1300N, 1400E). Gravel pit to left has been converted to home sites.
0.75+	44.65+	TURN RIGHT (south) at entrance to Gregory Gravel Company pit and scale house. NOTE: you **MUST** have permission to enter this property.
		STOP 10. Discussion of sand and gravel resources of the field trip area and rock collecting site.

END OF FIELD TRIP



Major geologic structures of Illinois, compiled by Janis D. Treworgy, Dec. 1979.

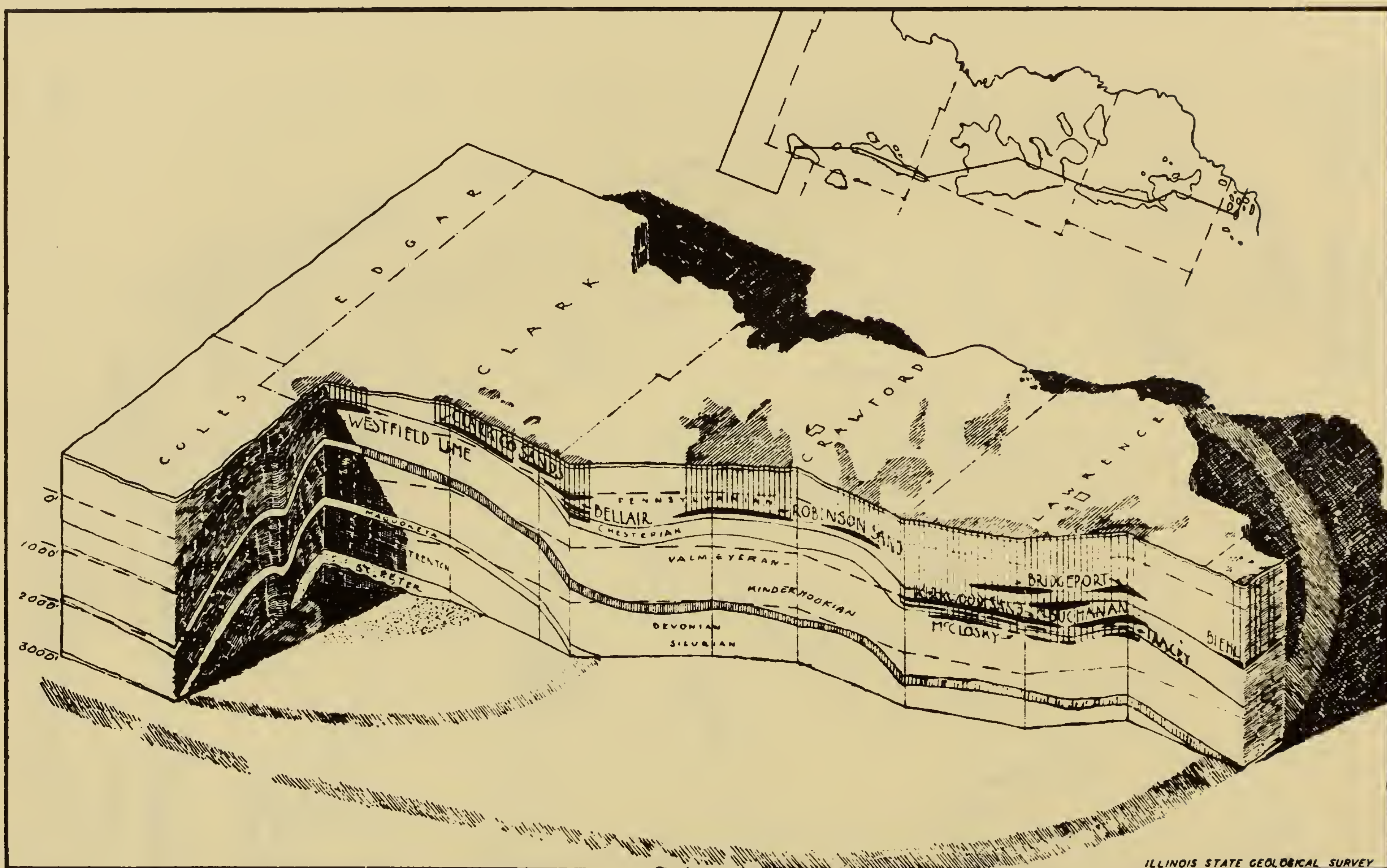
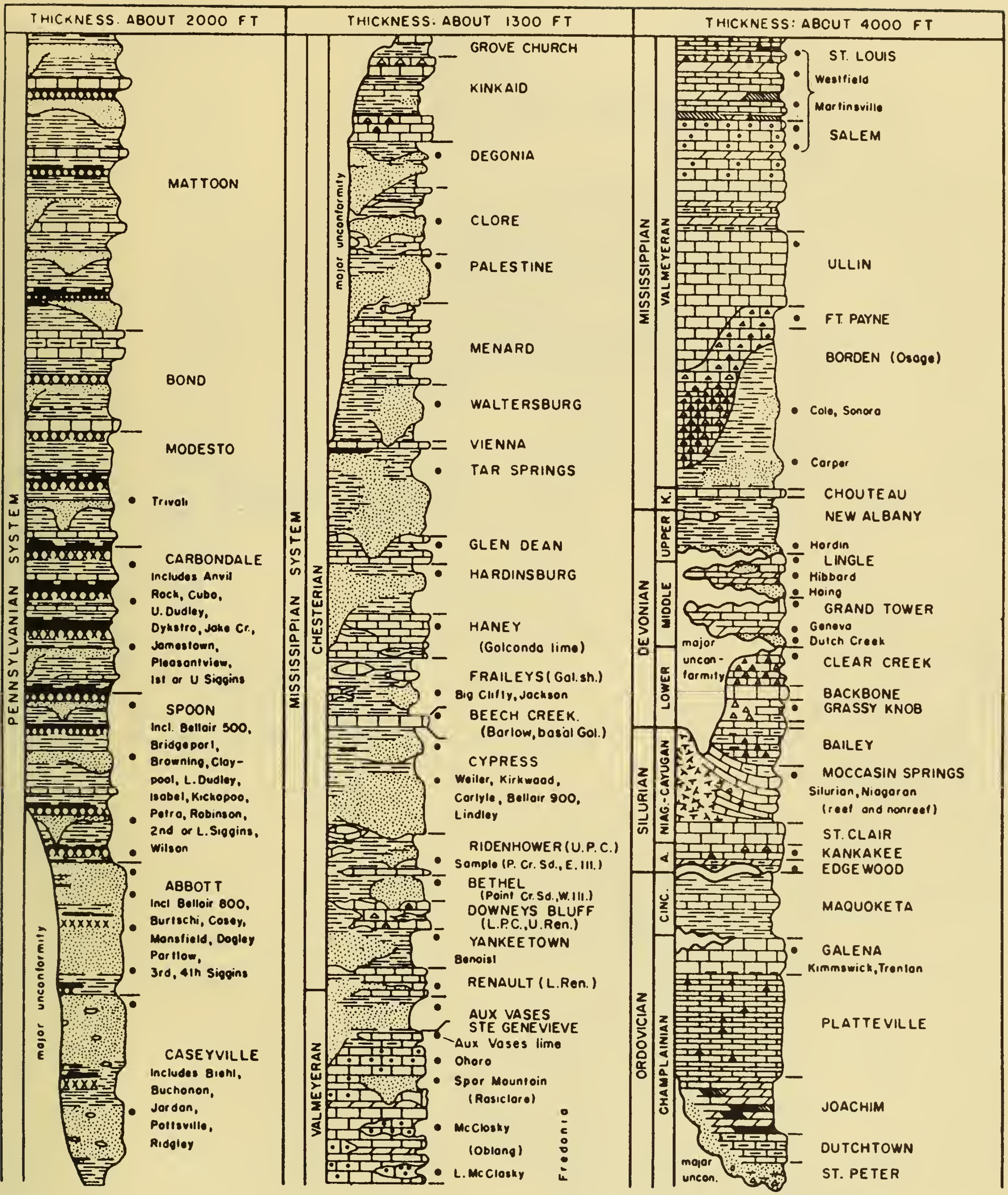
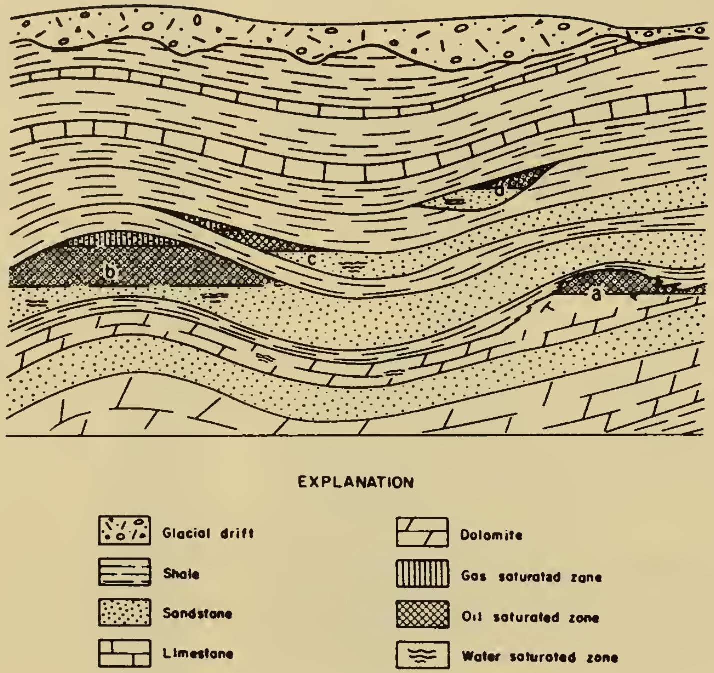


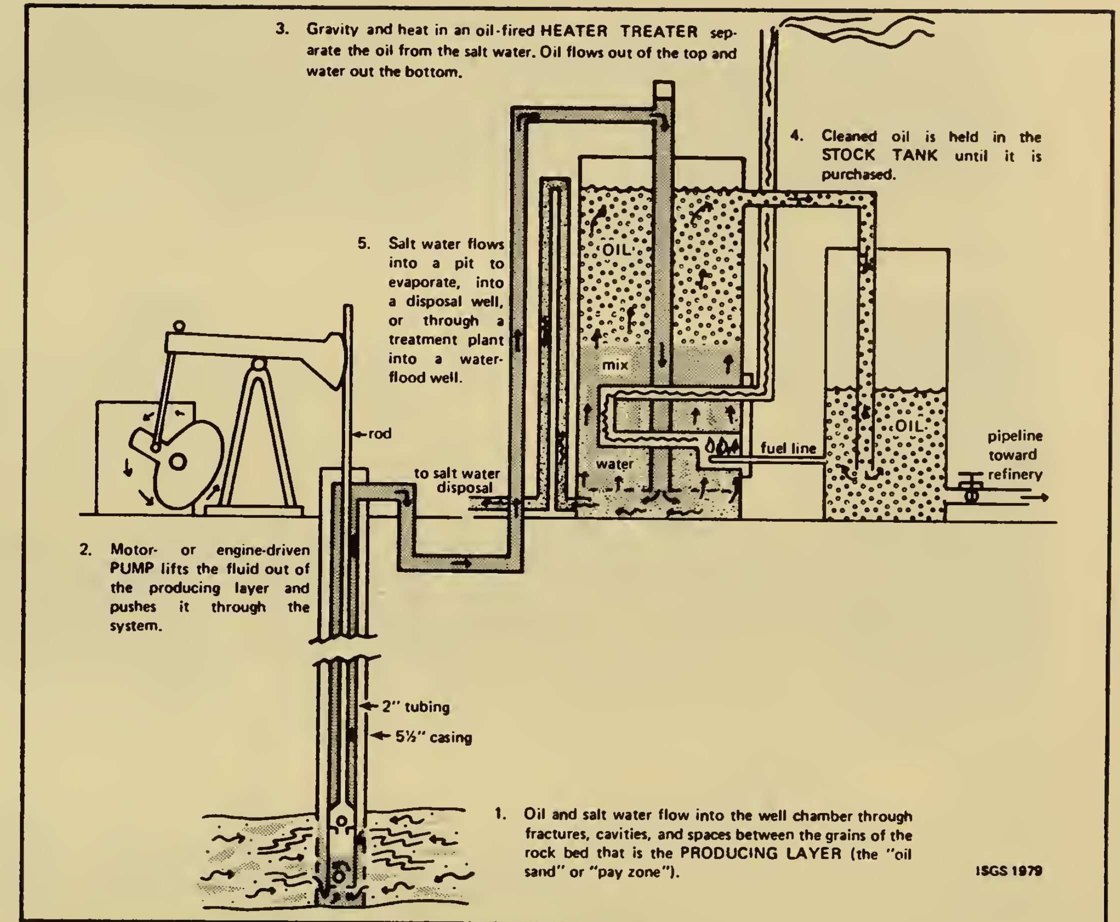
Plate 1 - A block diagram showing the generalized structure and thicknesses of the Paleozoic rock layers in the region around the field trip area. The outlines of the old southeastern Illinois oil fields are shown by hatching (////) on the surface of the block. The approximate locations of the oil-producing rock layers, or pay zones, are shown by named, black lenses (—) along the side of the block. From ISGS Circular 110 (1944, out of print).



Generalized geologic column of southern Illinois. Solid dots indicate oil and gas pay zones. Formation names are in capitals; other pay zones are not. About 4,000 feet of lower Ordovician and upper Cambrian rocks under the St. Peter are not shown. The names of the Kinderhookian, Niagaran, Alexandrian, and Cincinnatian Series are abbreviated as K., Niag., A., and Cinc., respectively. Variable vertical scale. (Originally prepared by David H. Swann.)



Types of structures in which oil is found in Illinois; (a) coral reefs, (b) anticlines, (c) pinch-outs, and (d) channel sandstones.



Schematic diagram of a common type of oil production unit in Illinois.


PHYSIOGRAPHIC DIVISIONS OF ILLINOIS
Reprinted 1970
TILL PLAINS SECTION
GREAT LAKE SECTION
WISCONSIN DRIFTLESS SECTION
Rock River Hill Country
WHEATON MORAINAL COUNTRY
Chicago Lake Plain
Green River Lowland
Bloomington Ridged Plain
Kankakee Plain
Galesburg Plain
DISSECTED TILL PLAINS SECTION
LINCOLN HILLS SECTION
Springfield Plain
TILL PLAINS SECTION
SALEM PLATEAU SECTION
Mt. Vernon Hill Country
SHAWNEE HILLS SECTION
MILES
0 20 40
Ozark Plateaus Province
Interior Low Plateaus Province
Central Lowland Province
Coastal Plain Province
ILLINOIS STATE GEOLOGICAL SURVEY

PLEISTOCENE GLACIATIONS IN ILLINOIS

Origin of the Glaciers

During the past million years or so, the period of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. Ice sheets formed in sub-arctic regions four different times and spread outward until they covered the northern parts of Europe and North America. In North America the four glaciations, in order of occurrence from the oldest to the youngest, are called the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed during periods when the mean annual temperature was perhaps 4° to 7° C (7° to 13° F) cooler than it is now and winter snows did not completely melt during the summers. Because the cooler periods lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was probably enough to lower sea level more than 300 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called drift. Drift that is ice-laid is called till. Water-laid drift is called outwash.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also unstratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders.

Tills may be deposited as end moraines, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as ground moraines, or till plains, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called outwash. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size--the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an esker. Cone-shaped mounds of coarse outwash, called kames, were formed where meltwater plunged through crevasses in the ice or into ponds along the edge of the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake quickly lost speed and almost immediately dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were moved across the lake bottom by wind-generated

currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an outwash plain. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as valley trains. Valley trains may be both extensive and thick deposits. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

Loess and Soils

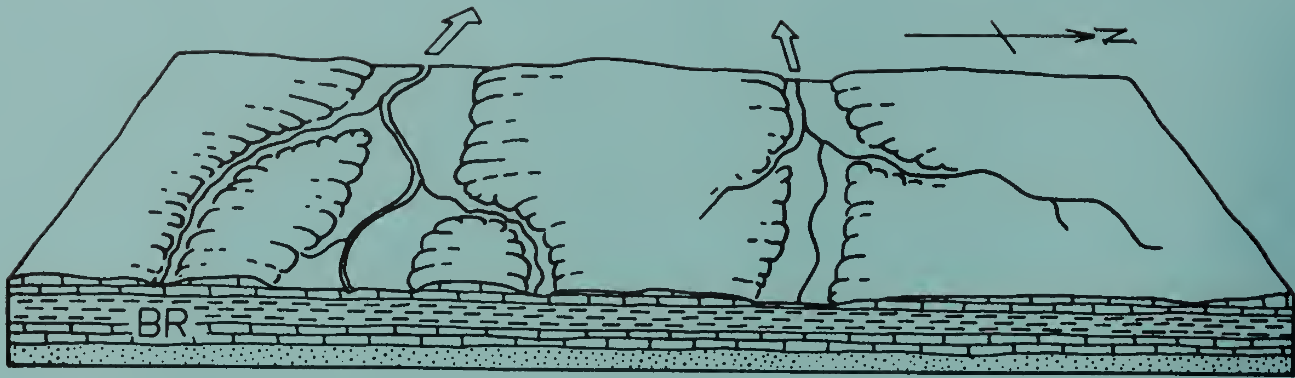
One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. Loess is the name given to such deposits of windblown silt and clay. The silt was blown from the valley trains on the floodplains. Most loess deposition occurred in the fall and winter seasons when low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but those that survive serve as keys to the identity of the beds and are evidence of the passage of a long interval of time.

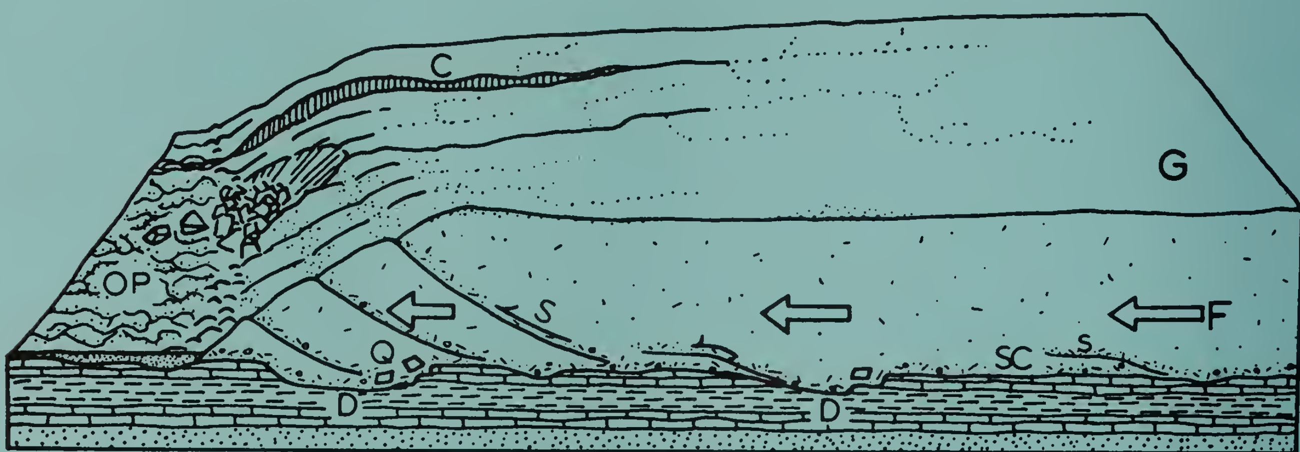
Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

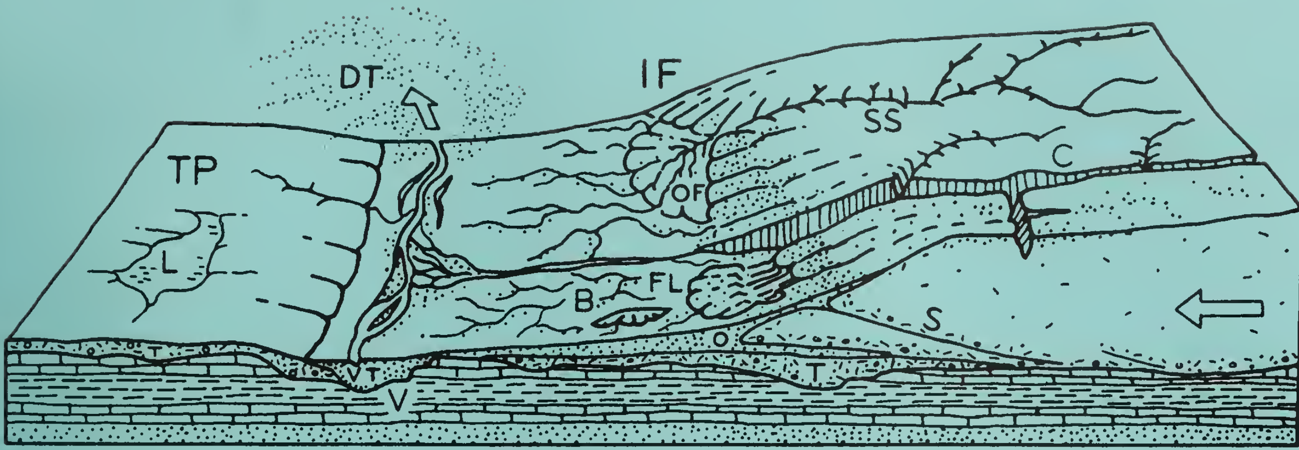
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated--layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.



1. <u>The Region Before Glaciation</u> - Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks--layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



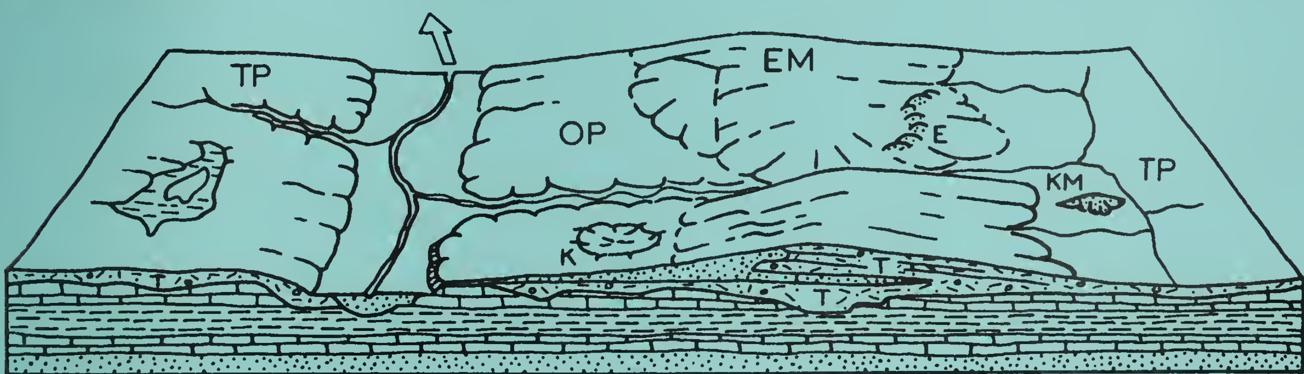
2. <u>The Glacier Advances Southward</u> - As the glacier (G) spreads out from its snowfield, it scours (SC) the soil and rock surface and quarries (Q)--pushes and plucks up--chunks of bedrock. These materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before the ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick , except near its margin. Its ice front advances perhaps as much as a third of a mile per year.



3. <u>The Glacier Deposits an End Moraine</u> - After the glacier advanced across the area, the climate warmed and the ice began to melt as fast as it advanced. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that was mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A superglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) was left as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remained a low spot in the terrain. As soon as its ice cover melted, meltwater drained down the valley, cutting it deeper. Later, outwash partly refilled the valley--the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles.



4. <u>The Region after Glaciation</u> - The climate has warmed even more, the whole ice sheet has melted, and the glaciation has ended. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

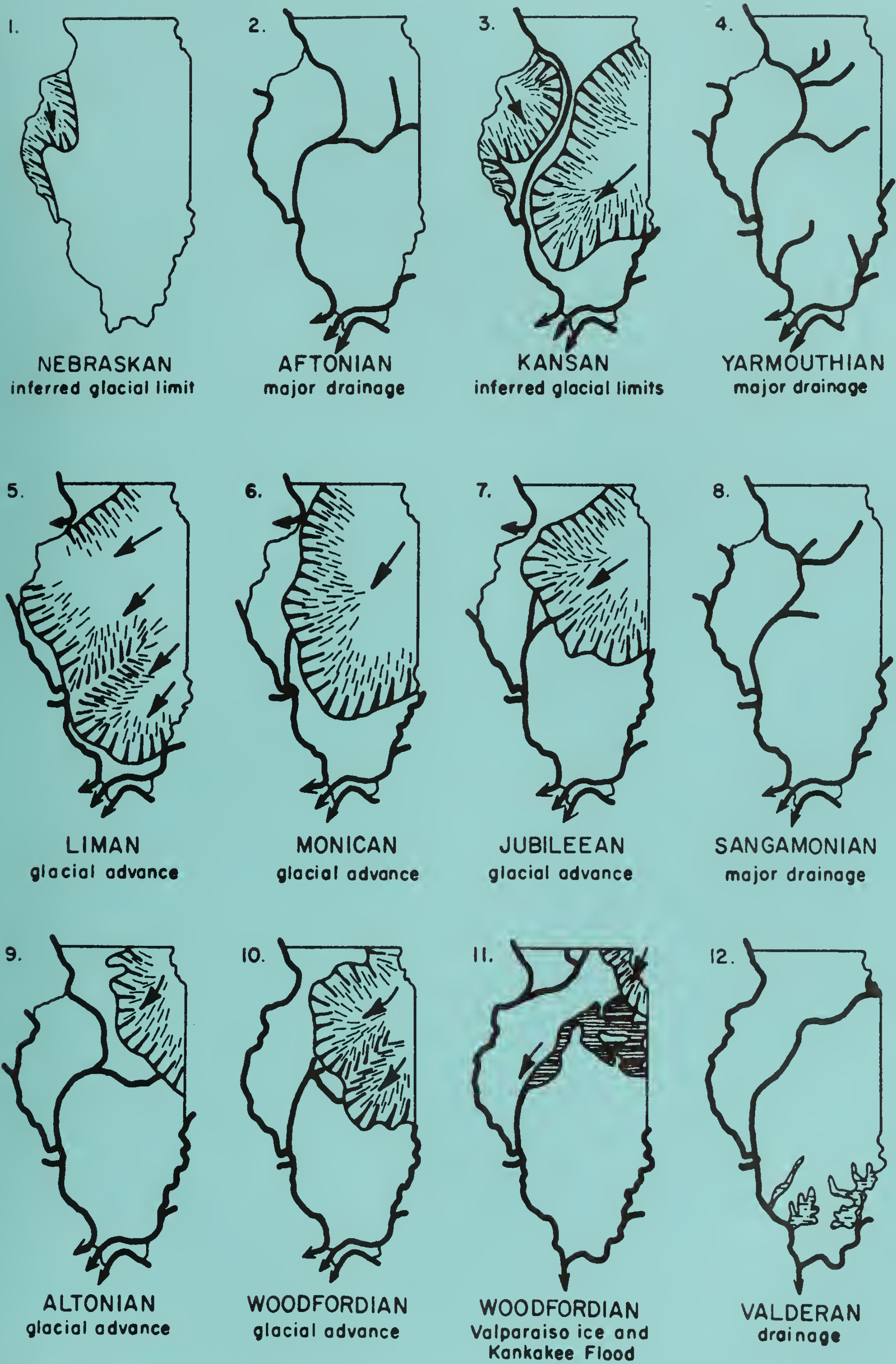
Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

TIME TABLE OF PLEISTOCENE GLACIATION

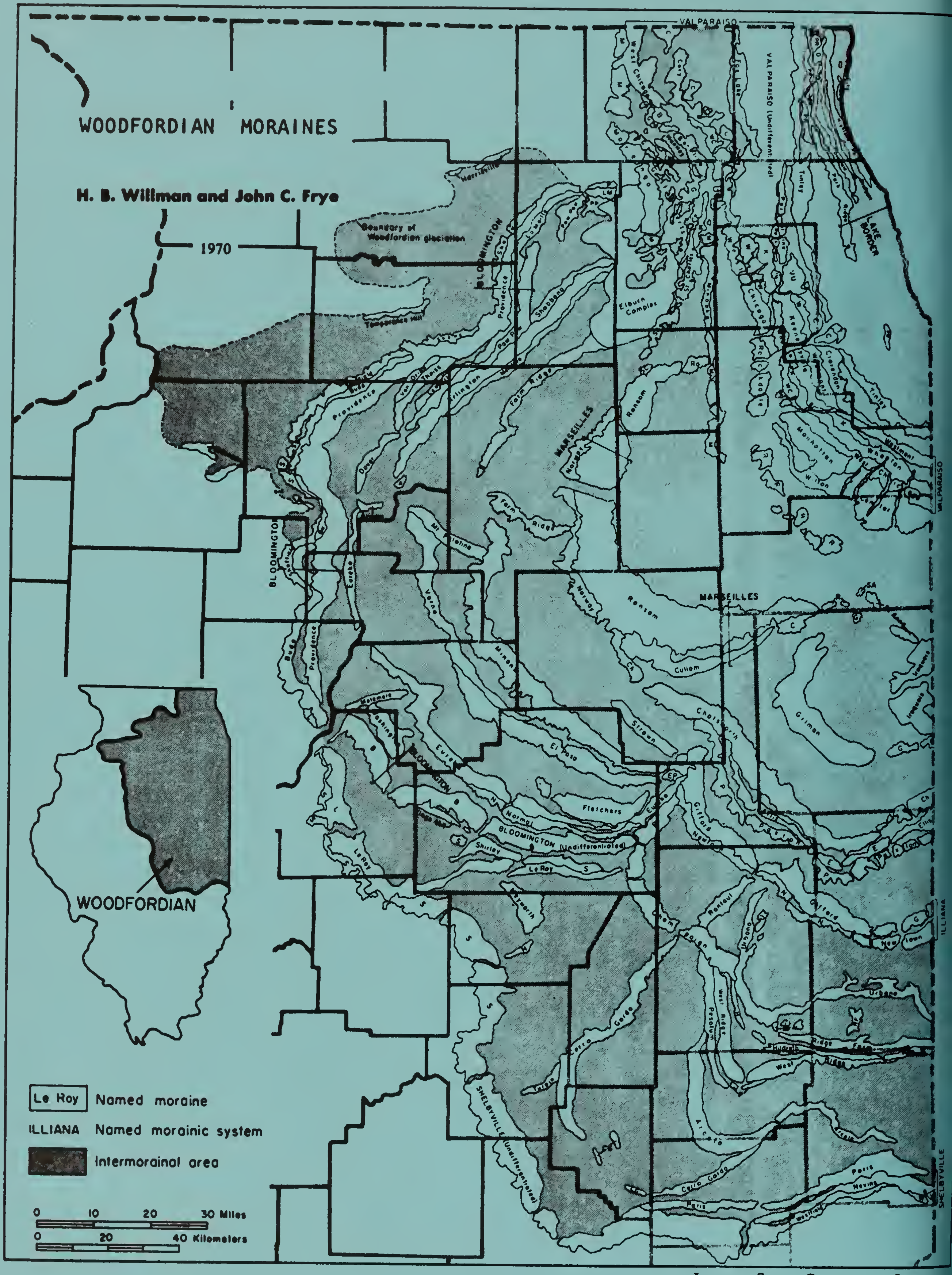
STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
HOLOCENE	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
	7,000		
WISCONSINAN (4th glacial)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
	11,000		
	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
	12,500		
	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers
	75,000		
SANGAMONIAN (3rd interglacial)		Soil, mature profile of weathering	
	175,000		
ILLINOIAN (3rd glacial)	Jubileean Monican Liman	Drift, loess Drift, loess Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	300,000		
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
	600,000		
KANSAN (2nd glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
	700,000		
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
	900,000		
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois
	1,200,000 or more		

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(From Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)



WOODFORDIAN MORAINES
H. B. Willman and John C. Frye
1970
Boundary of Woodfordian glaciation
VALPARAISO
VALPARAISO (Undifferentiated)
LAKE BORDER
BLOOMINGTON
MARSEILLES
BLOOMINGTON (Undifferentiated)
ILLIANA
SHELBYVILLE
SHELBYVILLE (Undifferentiated)
WOODFORDIAN
Le Roy Named moraine
ILLIANA Named morainic system
Intermorainal area
0 10 20 30 Miles
0 20 40 Kilometers

ILLINOIS STATE GEOLOGICAL SURVEY

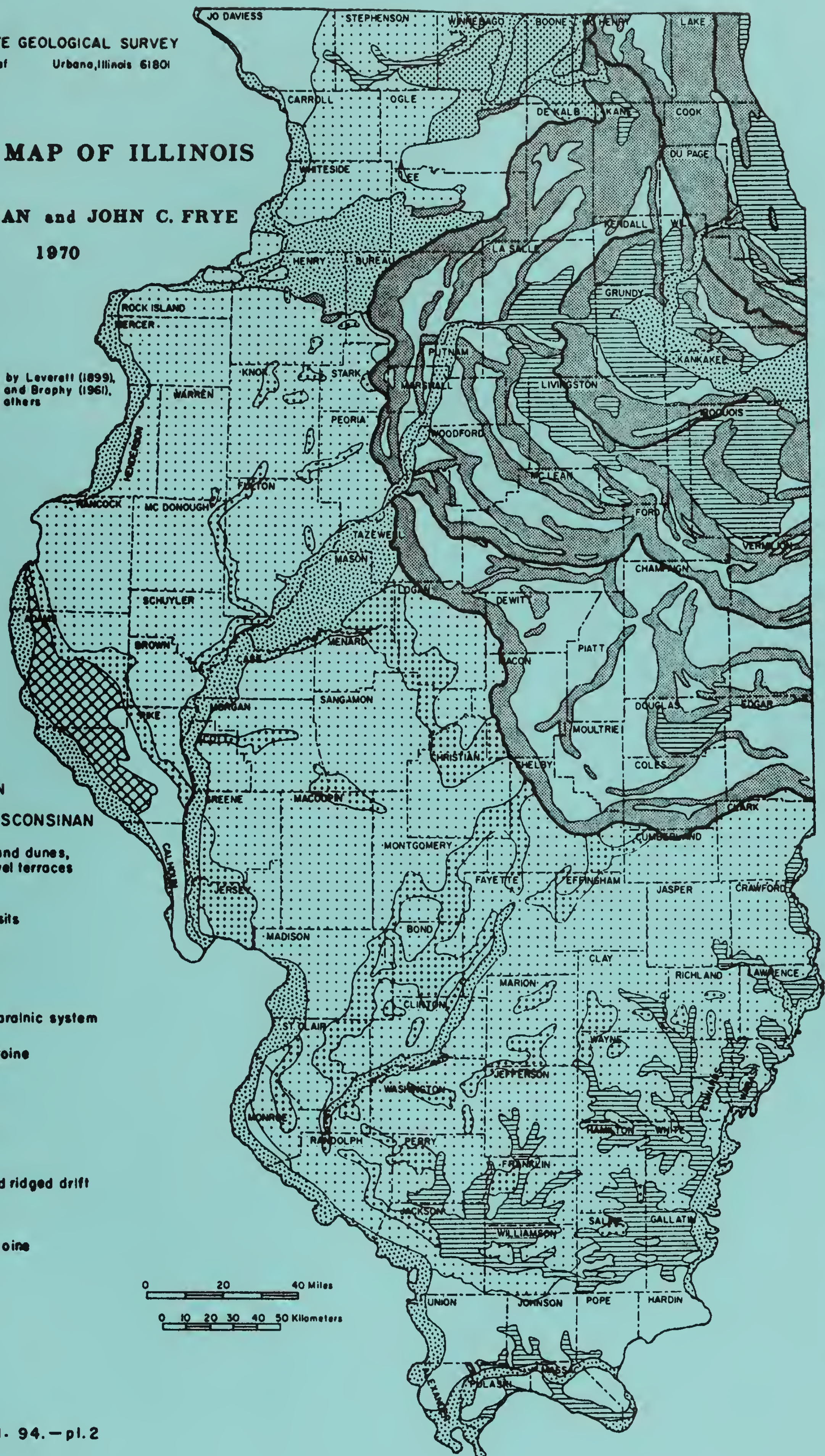
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblaw (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

Groundmoraine

KANSAN

Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

QUATERNARY DEPOSITS OF ILLINOIS

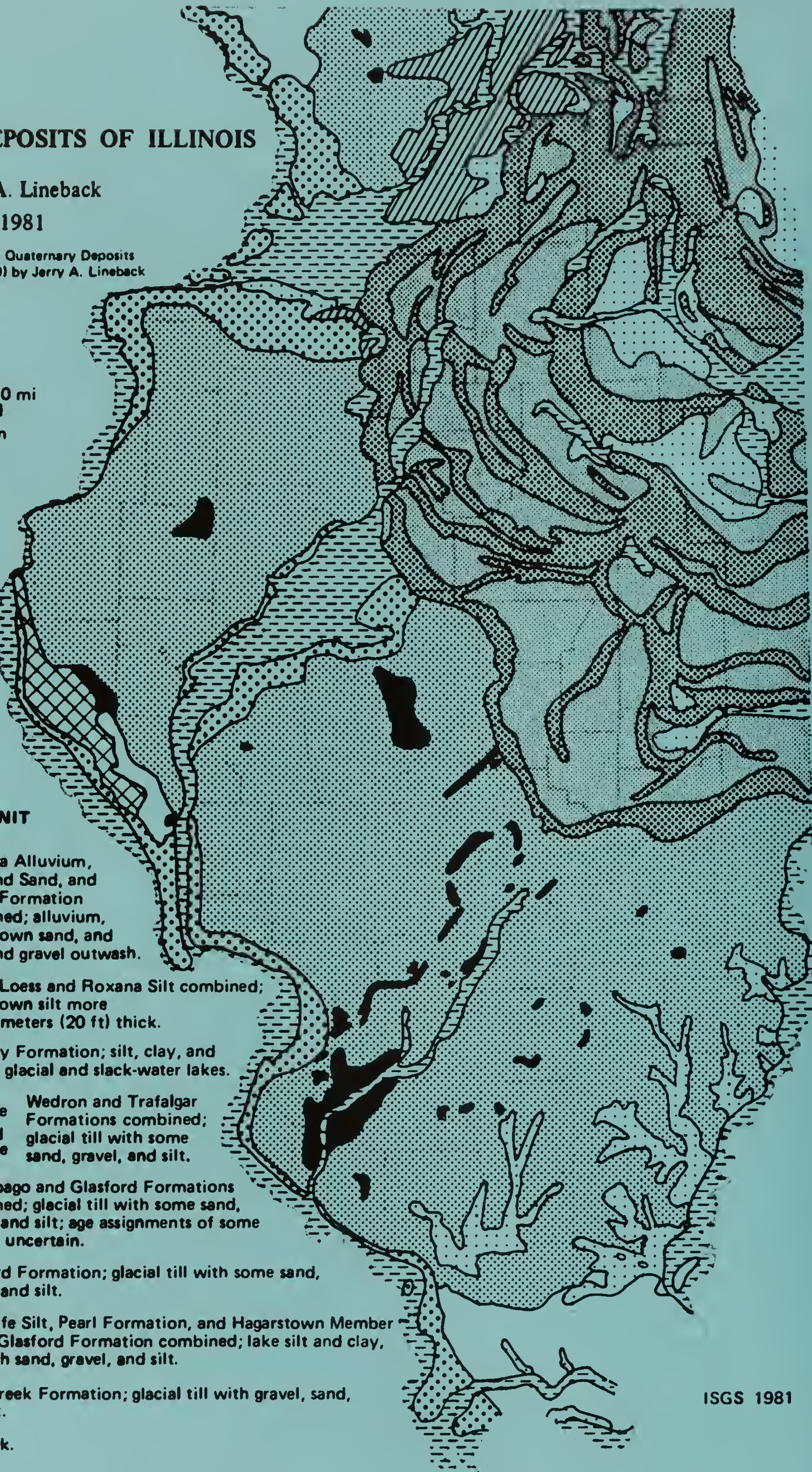
Jerry A. Lineback

1981

Modified from Quaternary Deposits of Illinois (1979) by Jerry A. Lineback

0 40 mi

0 50 km



AGE	UNIT
Holocene and Wisconsinan	Cahokia Alluvium, Parkland Sand, and Henry Formation combined; alluvium, windblown sand, and sand and gravel outwash.
Wisconsinan	Peoria Loess and Roxana Silt combined; windblown silt more than 6 meters (20 ft) thick.
	Equality Formation; silt, clay, and sand in glacial and slack-water lakes.
	Moraine / Ground moraine — Wedron and Trafalgar Formations combined; glacial till with some sand, gravel, and silt.
Wisconsinan and Illinoian	Winnebago and Glasford Formations combined; glacial till with some sand, gravel, and silt; age assignments of some units is uncertain.
Illinoian	Glasford Formation; glacial till with some sand, gravel, and silt.
	Teneriffe Silt, Pearl Formation, and Hagarstown Member of the Glasford Formation combined; lake silt and clay, outwash sand, gravel, and silt.
Pre-Illinoian	Wolf Creek Formation; glacial till with gravel, sand, and silt.
	Bedrock.

Plate 2 - Landforms associated with the Wabash Valley Drainage System through the Robinson area. This figure reproduces part of Plate 1 in Physiography of the Lower Wabash Valley by M.M. Fidlar (Indiana Department of Natural Resources, Geological Survey, Bulletin 2, 1948).

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

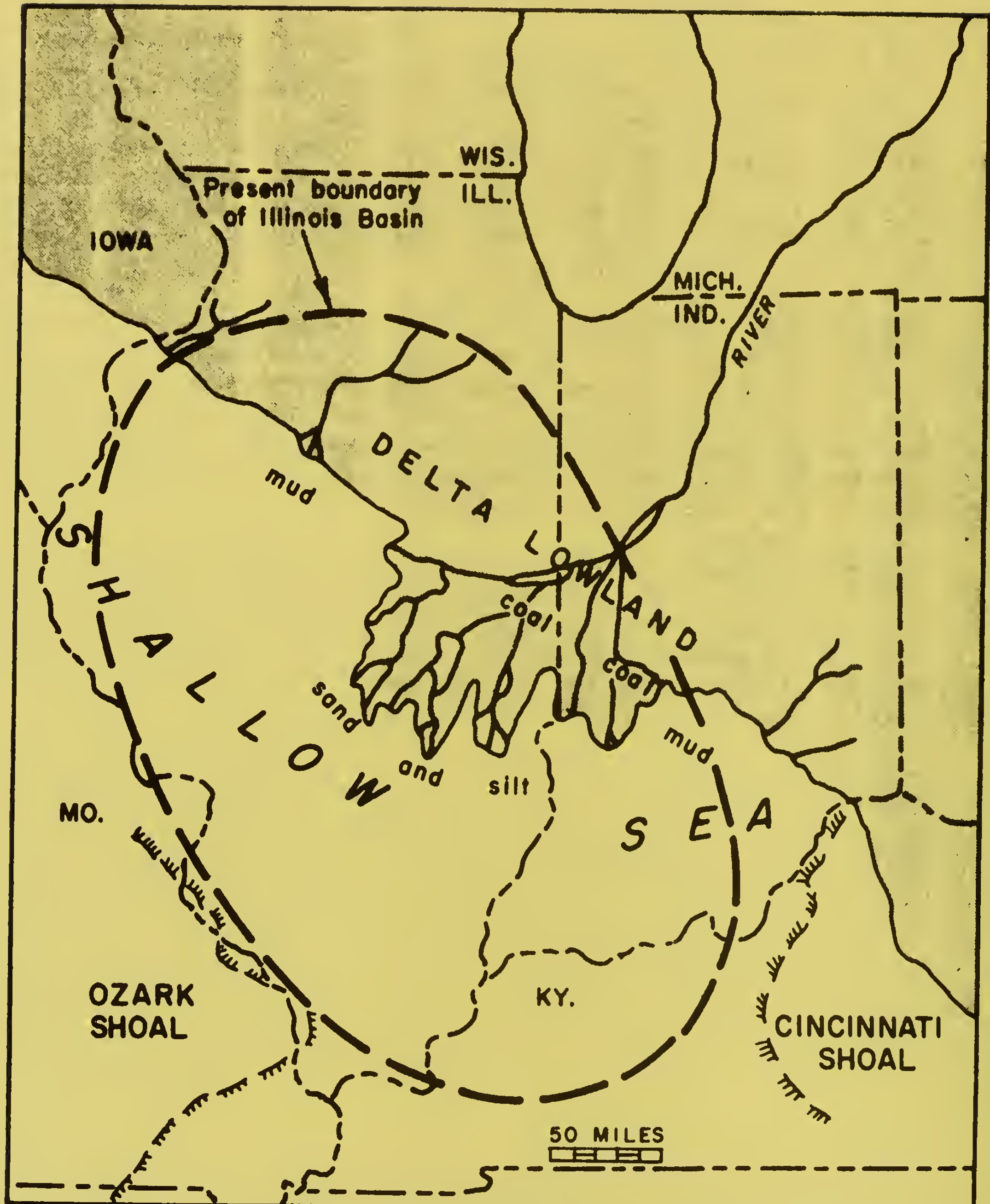
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Fresh-water limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and

limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and non-marine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

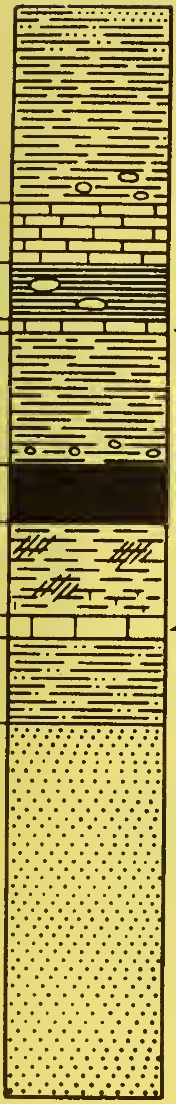
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.



10 Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

9 Limestone; contains marine fossils.

8 Shale, black, hard, laminated; contains large spheroidal concretions and marine fossils.

7 Limestone; contains marine fossils.

6 Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

5 Coal; locally contains clay or shale partings.

4 Underclay, mostly medium to light gray but dark gray at top; upper part noncalcareous, lower part calcareous.

3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

2 Shale, gray, sandy.

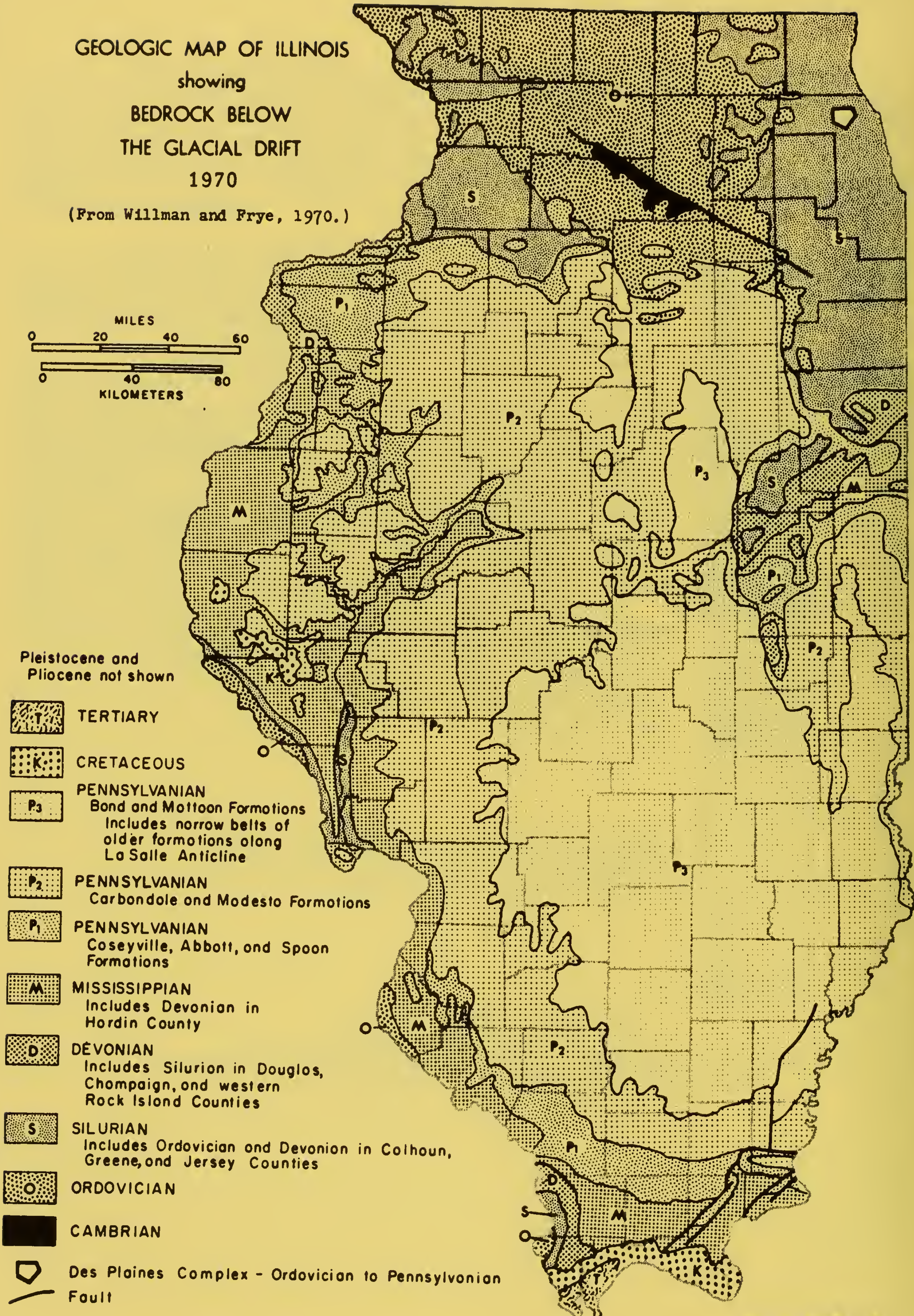
1 Sandstone, fine grained, micaceous, and siltstone, argillaceous; varies from massive to thin bedded; usually has an uneven lower surface.

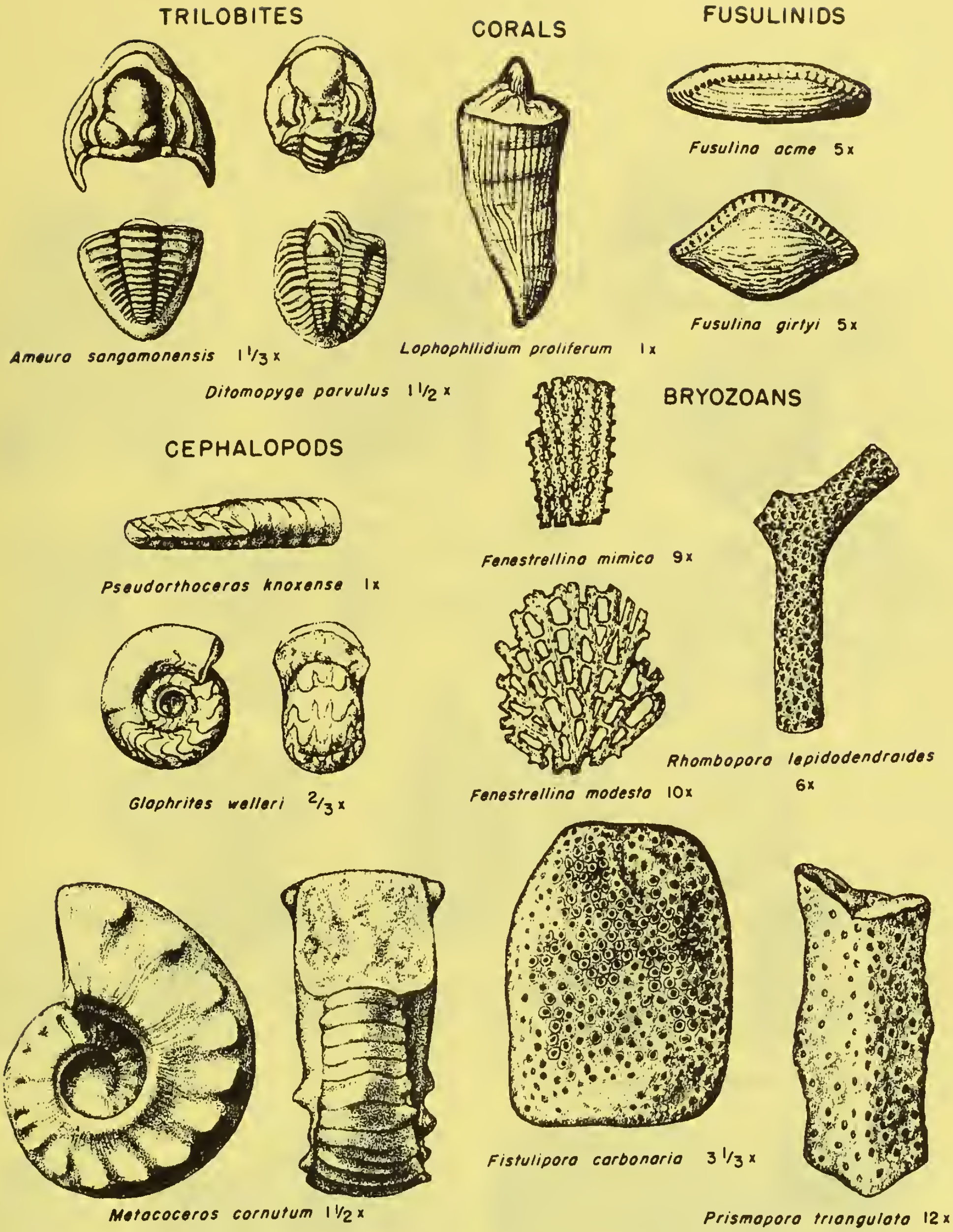
AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)

GEOLOGIC MAP OF ILLINOIS
showing
BEDROCK BELOW
THE GLACIAL DRIFT
1970

(From Willman and Frye, 1970.)



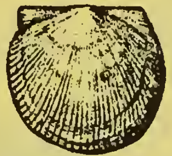

TRILOBITES
Ameura sangamonensis 1 1/3 x
Ditomopyge parvulus 1 1/2 x
CORALS
Lophophllidium proliferum 1 x
FUSULINIDS
Fusulina acme 5 x
Fusulina girtyi 5 x
CEPHALOPODS
Pseudorthoceras knoxense 1 x
Glaphrites welleri 2/3 x
Metacoceros cornutum 1 1/2 x
BRYOZOANS
Fenestrellina mimica 9 x
Fenestrellina modesta 10 x
Rhombopora lepidodendroides 6 x
Fistulipora carbonaria 3 1/3 x
Prismopora triangulata 12 x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x

Edmonia ovata 2x

Astartella concentrica 1x



Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

Cardiomorpha missouriensis "Type B" 1½x

GASTROPODS

Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

Donaldina robusta 8x

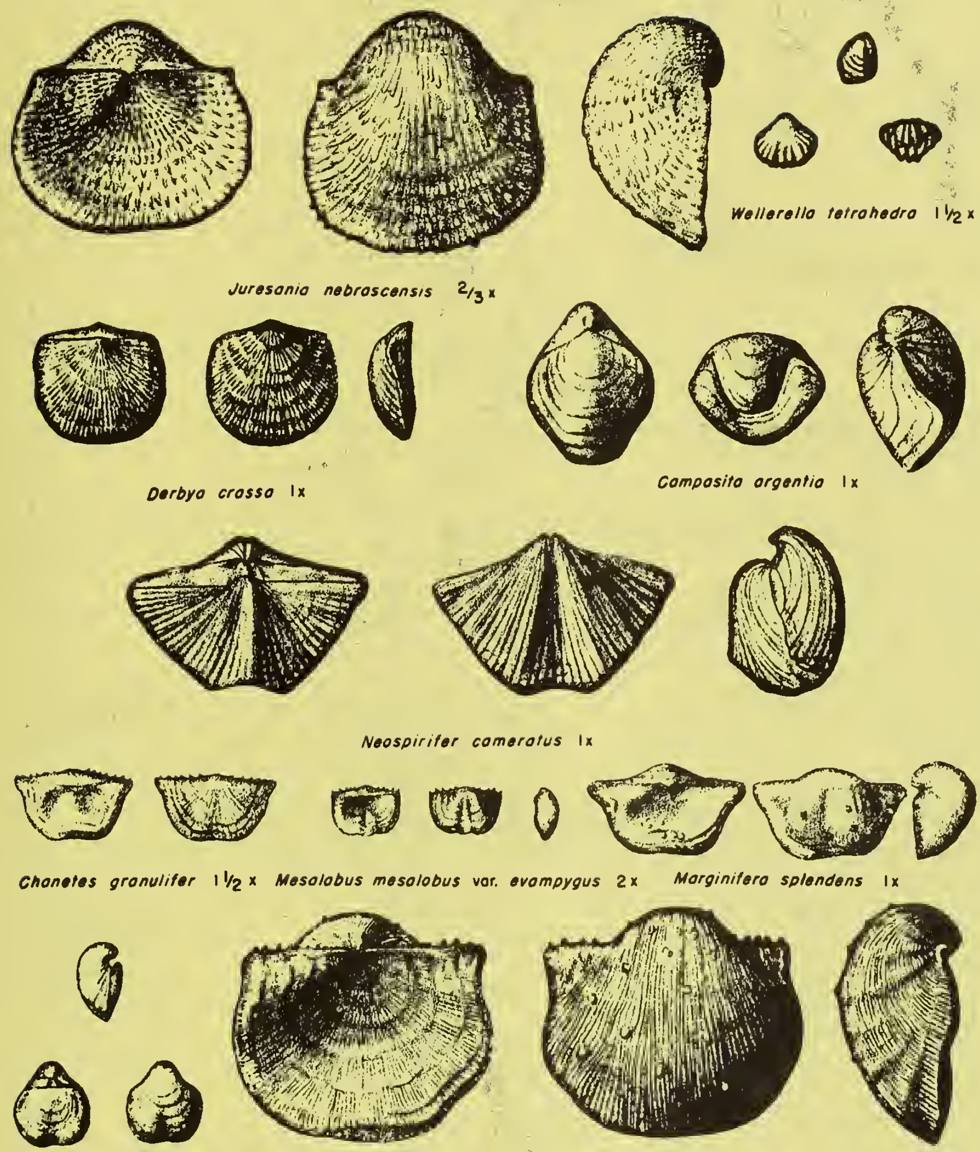
Naticopsis (Jedria) ventricosa 1½x

Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabrocingulum (Glabrocingulum) grayvillense 3x

BRACHIOPODS



Wellerella tetrahedra 1½ x

Juresania nebrascensis ⅔ x

Derbya crassa 1x

Composita argentia 1x

Neospirifer cameratus 1x

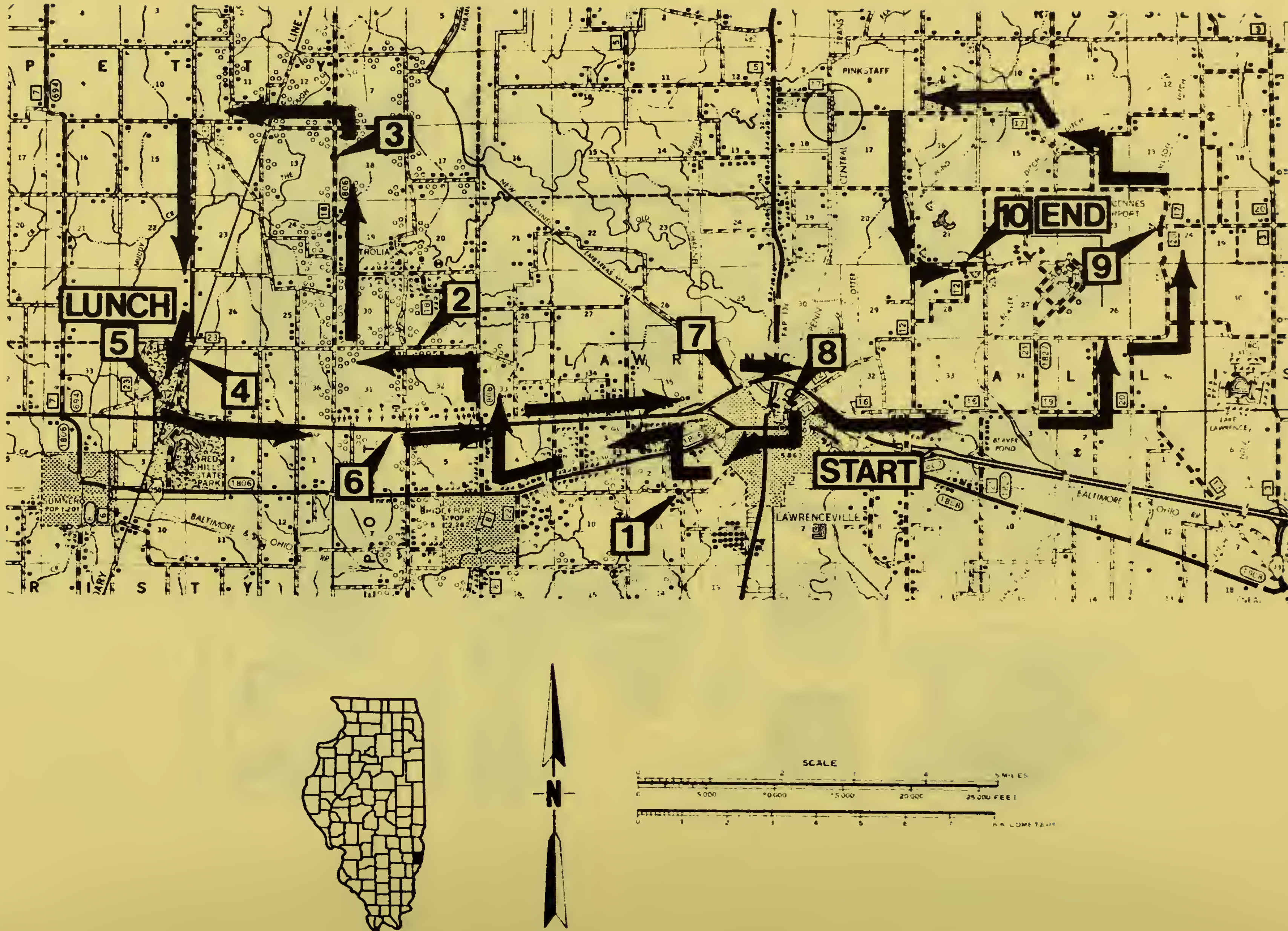
Chonetes granulifer 1½ x

Mesolobus mesolobus var. *evampygus* 2x

Marginifera splendens 1x

Crurithyris planoconvexa 2x

Linoproductus "cora" 1x


START
1
2
3
4
LUNCH
5
6
7
8
9
10
END
LAWRENCEVILLE
PINKSTAFF
SUMNER
BRIDGEPORT
RED HILLS STATE PARK
BALTIMORE & OHIO
N
SCALE